SPARSE AND EFFICIENT BLOCK FACTORIZATION FOR INTERACTION DATA

Reference to Related Applications

The present application is a continuation-in-part of U.S. Patent Application No. 10/354,241, filed January 29, 2003, titled "COMPRESSION OF INTERACTION DATA USING DIRECTIONAL SOURCES AND/OR TESTERS," which is a continuation-in-part of U.S. Patent Application No. 09/676,727, filed September 29, 2000, titled "COMPRESSION AND COMPRESSED INVERSION OF INTERACTION DATA," the entire contents of both prior applications are hereby incorporated by reference. The present application also claims priority from U.S. Provisional Application No. 60/175,454, filed January 10, 2000, the entire contents of which is hereby incorporated by reference. The present application also claims priority benefit of U.S. Provisional Application No. 60/396,133, filed July15, 2002, titled "SPARSE AND EFFICIENT BLOCK FACTORIZATION FOR INTERACTION DATA," the entire contents of which is hereby incorporated by reference.

Computer Program Listing

A computer program listing in Appendix A lists a sample computer program for one embodiment of the invention.

Background of the Invention

Field of the Invention

The invention relates to methods for compressing the stored data, and methods for manipulating the compressed data, in numerical solutions such as, for example, antenna radiation-type problems solved using the method of moments, and similar problems involving mutual interactions that approach an asymptotic form for large distances.

Description of the Related Art

Many numerical techniques are based on a "divide and conquer" strategy wherein a complex structure or a complex problem is broken up into a number of smaller, more easily solved problems. Such strategies are particularly useful for solving integral equation problems involving radiation, heat transfer, scattering, mechanical stress, vibration, and the like. In a typical solution, a larger structure is broken up into a number of smaller structures, called elements, and the coupling or interaction between each element and every other element is calculated. For example, if a structure is broken up into 16 elements, then the inter-element mutual interaction (or coupling) between each element and every other element can be expressed as a 16 by 16 interaction matrix.

As computers become more powerful, such element-based numerical techniques are becoming increasingly important. However, when it is necessary to simultaneously keep track of many, or all, mutual interactions, the number of such interactions grows very quickly. The size of the interaction matrix often becomes so large that data compression schemes are desirable or even essential. Also, the number of computer operations necessary to process the data stored in the interaction matrix can become excessive. The speed of the compression scheme is also important, especially if the data in the interaction matrix has to be decompressed before it can be used.

Typically, especially with radiation-type problems involving sound, vibration, stress, temperature, electromagnetic radiation, and the like, elements that are physically close to one another produce strong interactions. Elements that are relatively far apart (usually where distance is expressed in terms of a size, wavelength, or other similar metric) will usually couple less strongly. For example, when describing the sound emanating from a loudspeaker, the sound will change in character relatively quickly in the vicinity of that speaker. If a person standing very near the speaker moves one foot closer, the sound may get noticeably louder. However, if that person is sitting at the other end of a room, and moves one foot closer, then the change in volume of the sound will be relatively small. This is an example of a general property of many physical systems. Often, in describing the interaction of two nearby objects, relatively more detail